

Improving Turbulence SIGMET Decision Support With Ellrod-Knox Guidance

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INTRODUCTION

The Aviation Weather Center (AWC) issues international turbulence Significant Meteorological Information (SIGMETs) over the North Atlantic and Pacific Oceans (Fig. 1). SIGMET issuance warns the international aviation community of severe turbulence, necessitate en route diversions, and may require more fuel on a given flight. SIGMET issuance typically occurs *after* a pilot report (PIREP) of severe clear air turbulence (CAT) is received. The Ellrod-Knox (EK) turbulence diagnostic is a tool recently introduced at AWC which provides improved forecaster guidance for areas of potential CAT. This study examines cases where forecasters utilized Ellrod-Knox to issue pre-emptive SIGMETs *before* receiving a PIREP of severe CAT to improve decision support and air traffic safety.

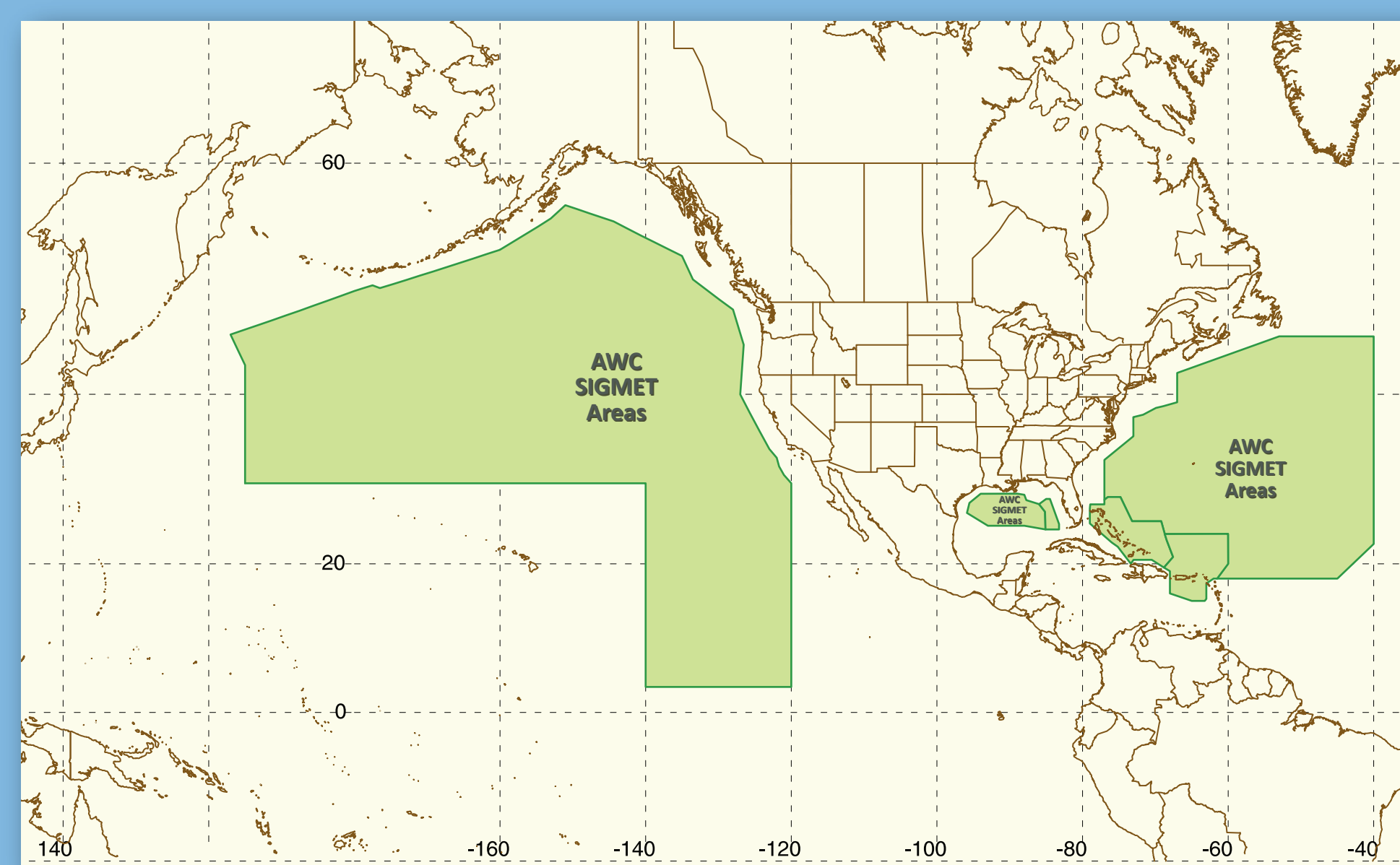


Figure 1. AWC area of responsibility for International SIGMETs (shaded)

International Forecaster Situational Awareness for SIGMET Issuance

Forecaster situational awareness for SIGMET issuance in the areas shown in Fig. 1 utilize satellite, model data, lightning, and PIREPs. International SIGMETs typically last four hours, except for volcanic ash and tropical cyclones, which last for six hours. Currently, there are no Airman's Meteorological Information (AIRMETs) for these regions. International flights with large aircraft carrying hundreds of people in these regions require advance warning for potential severe clear air turbulence (CAT). This project tests new turbulence SIGMET decision support tools to improve situational awareness and increase the lead time of International SIGMET issuance.

Case 1: North Pacific Ocean: 1-2 Feb 2014

- Area of interest: over the North Pacific Ocean based on satellite, model diagnostics, model soundings, and PIREPs
- Forecaster contacted Center Weather Service Unit (CWSU) at Oakland Center (ZOA) to coordinate
- No PIREPs reported to ZOA
- Updated GFS Ellrod-Knox indicated possible severe CAT → at 2300Z forecaster issued pre-emptive SIGMET for severe CAT from FL250 to FL350
- After SIGMET issuance, at 0032Z moderate turbulence PIREP at FL370 received → the SIGMET base and top revised to FL260 to FL370
- At 0226Z, severe turbulence PIREP at FL380 received inside SIGMET. This was 3 hours, 26 minutes after the SIGMET issuance
- Forecaster immediately raised the SIGMET to FL390
- SIGMET issuance resulted in at least one reroute to avoid severe CAT reported by ZOA

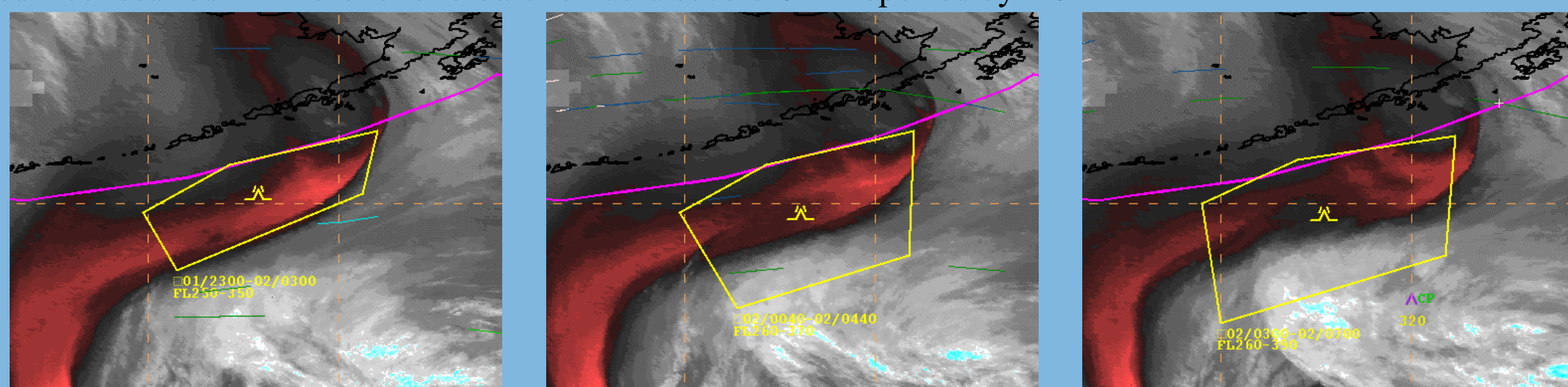


Figure 2. Left: 2315Z WV satellite, ASDI_H, PIREPs, and International SIGMETs
Middle: 0115Z WV satellite, ASDI_H, PIREPs, and International SIGMETs
Right: 0315Z WV satellite, ASDI_H, PIREPs, and International SIGMETs

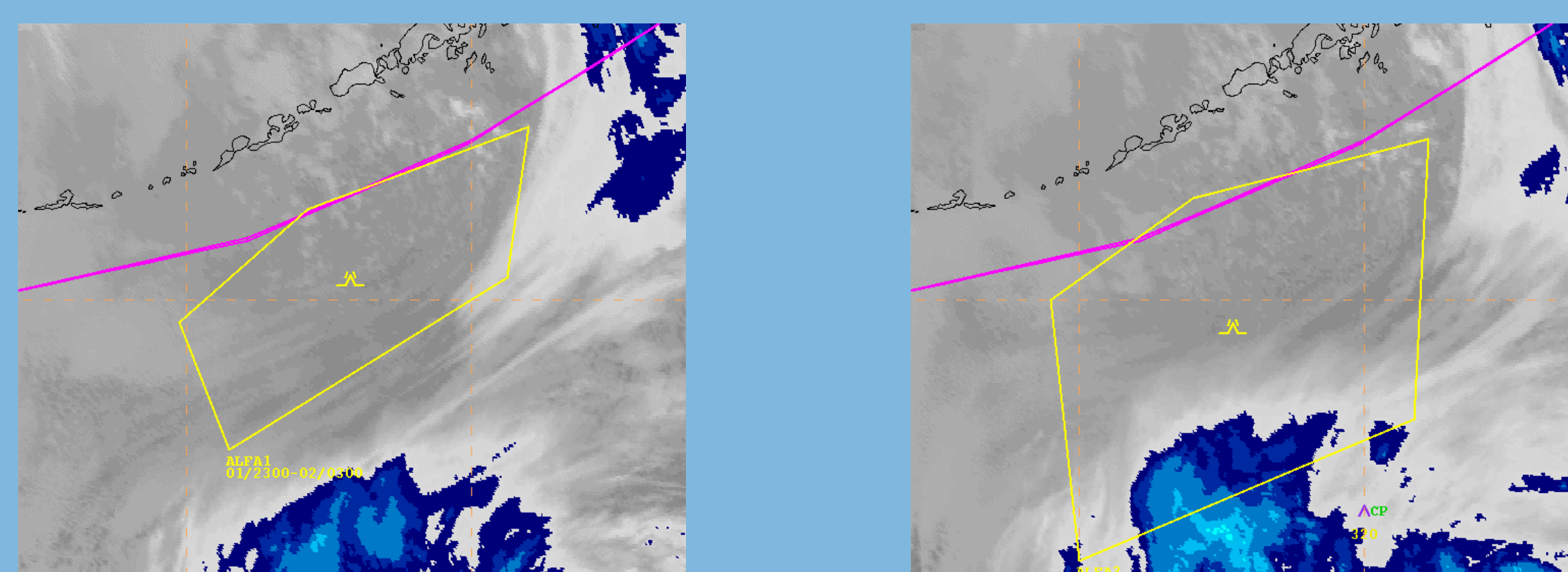


Figure 3. Left: 2315Z IR satellite, PIREPs, and International SIGMETs
Right: 0315Z IR satellite, PIREPs, and International SIGMETs

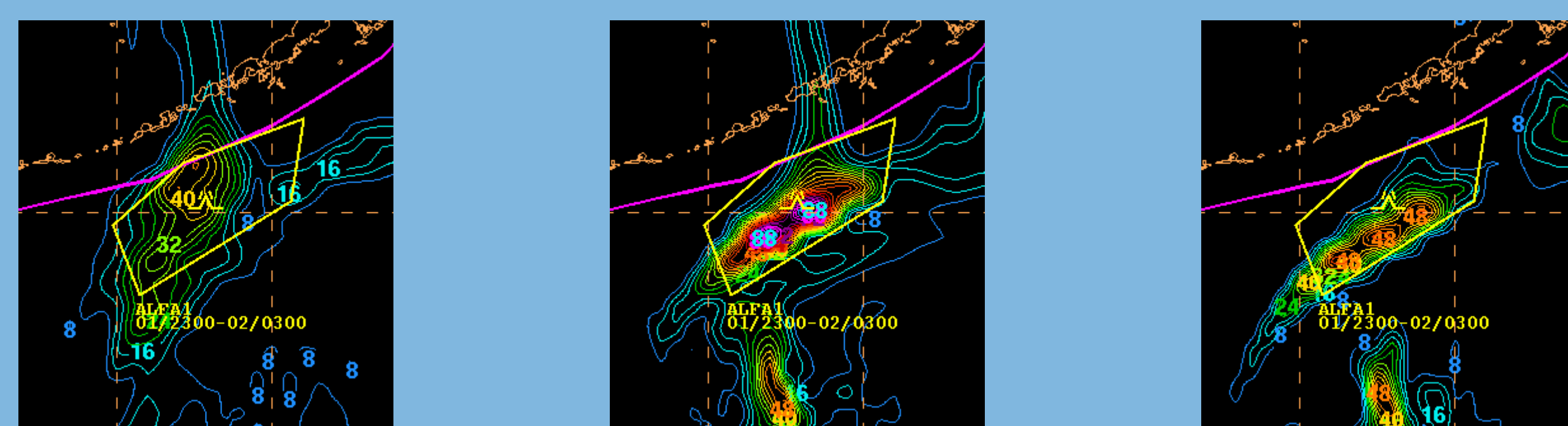


Figure 4. Left: GFS 250-300 hPa Ellrod-Knox 6 hr forecast from the 18Z run on 02/01/14 and SIGMET "Alfa 1"
Middle: GFS 300-350 hPa Ellrod-Knox 6 hr forecast from the 18Z run on 02/01/14 and SIGMET "Alfa 1"
Right: GFS 350-400 hPa Ellrod-Knox 6 hr forecast from the 18Z run on 02/01/14 and SIGMET "Alfa 1"

Case 2: North Pacific Ocean: 15-16 Dec 2014

- Area of interest: over the North Pacific Ocean based on satellite, model diagnostics, model soundings, and PIREPs
- GFS Ellrod-Knox indicated possible severe CAT developing by 1500Z over North Pacific Ocean
- After coordination with Center Weather Service Unit (CWSU) at Oakland Center (ZOA), AWC issued a pre-emptive clear air turbulence SIGMET; even though no severe PIREPs were yet reported
- At 1305Z, AWC issued pre-emptive clear air turbulence SIGMET from FL260 to FL380
- At 1442Z, a moderate to severe turbulence PIREP at FL280 was received just outside the SIGMET boundary
- At 1505Z revised SIGMET boundaries based on PIREP → subsequent SIGMETs issued during shift
- Next forecast shift continued SIGMET with revised boundaries → additional severe reports occurred within SIGMET
- SIGMET issuance with increased lead time resulted in reroutes around and/or above to avoid severe CAT

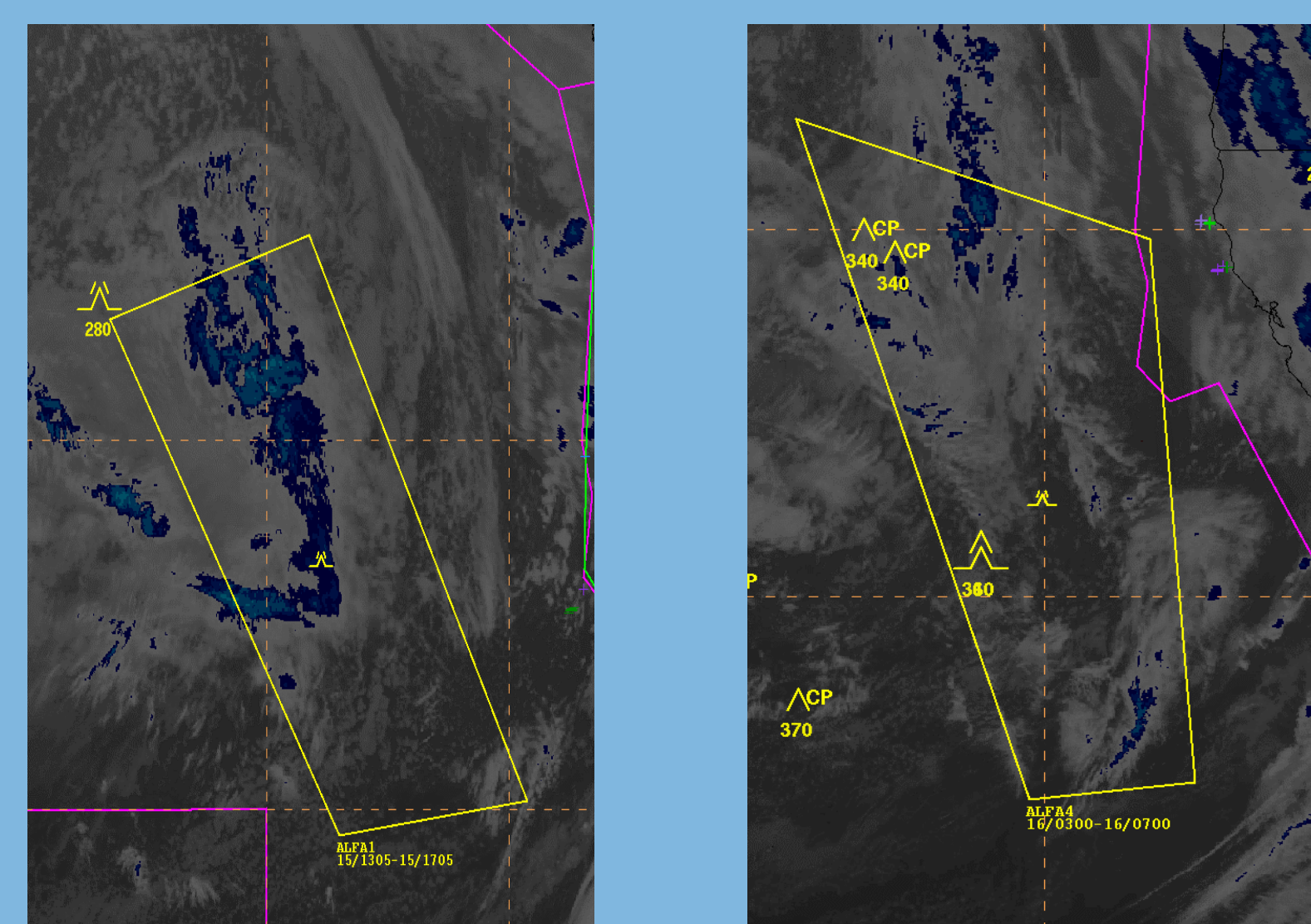


Figure 5. Left: 1345Z IR satellite, PIREPs, and International SIGMETs
Right: 0245Z IR satellite, PIREPs, and International SIGMETs

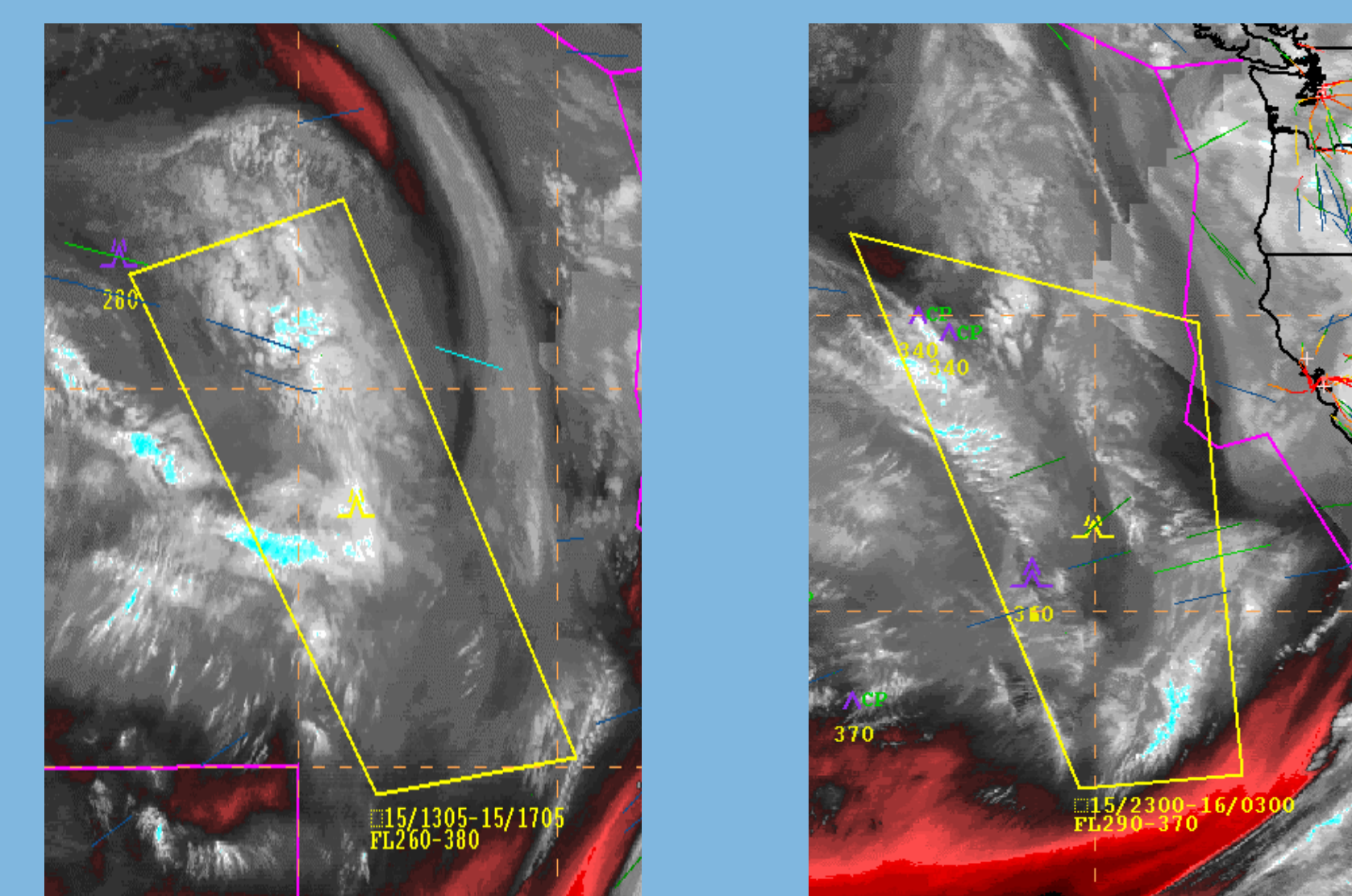


Figure 6. Left: 1345Z WV satellite, ASDI_H, PIREPs, and International SIGMETs
Right: 0245Z WV satellite, ASDI_H, PIREPs, and International SIGMETs

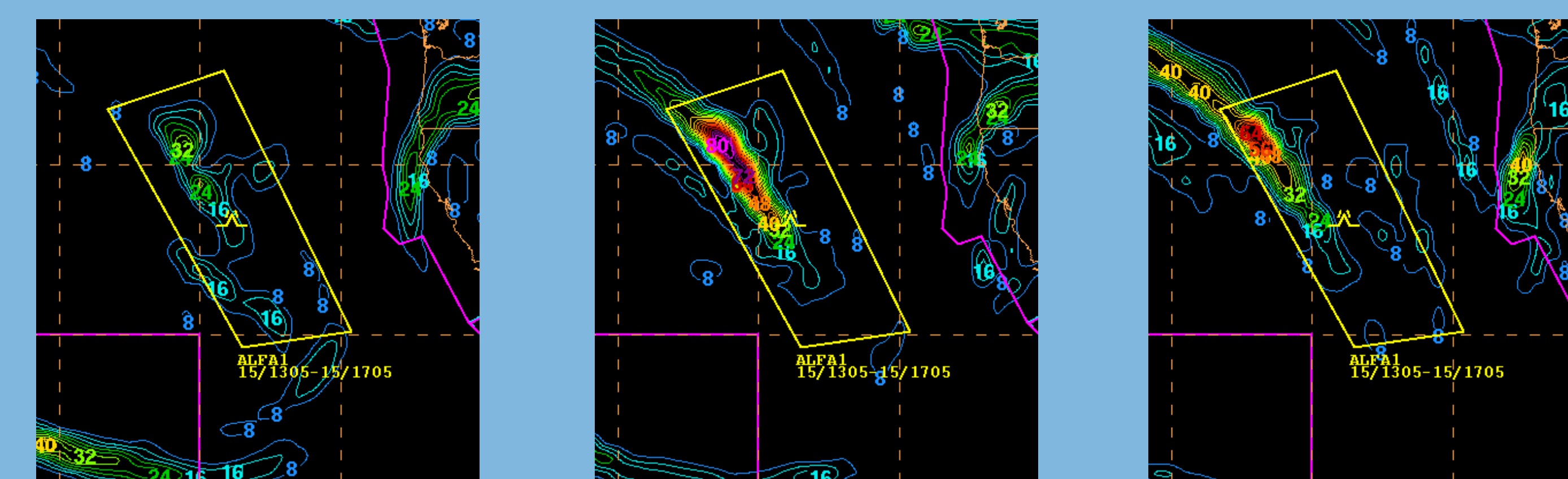


Figure 7. Left: GFS 250-300 hPa Ellrod-Knox 9 hr forecast from the 06Z run on 12/15/14 and International SIGMET "Alfa 1"
Middle: GFS 300-350 hPa Ellrod-Knox 9 hr forecast from the 06Z run on 12/15/14 and International SIGMET "Alfa 1"
Right: GFS 350-400 hPa Ellrod-Knox 9 hr forecast from the 06Z run on 12/15/14 and International SIGMET "Alfa 1"

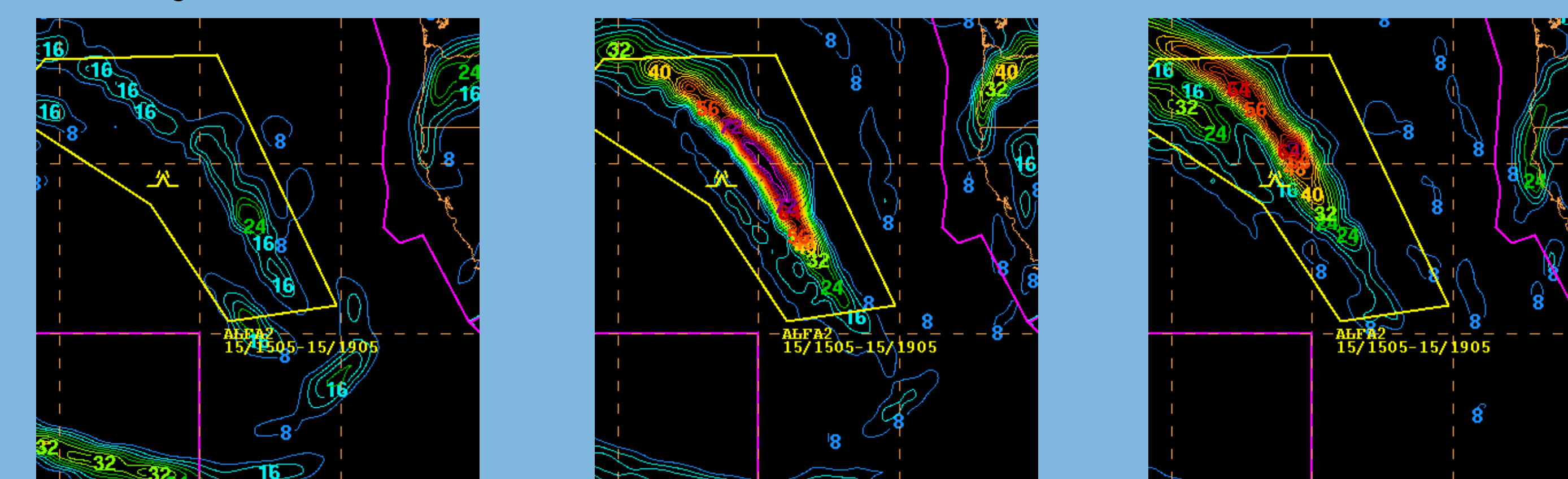


Figure 8. Left: GFS 250-300 hPa Ellrod-Knox 6 hr forecast from the 12Z run on 12/15/14 and International SIGMET "Alfa 2"
Middle: GFS 300-350 hPa Ellrod-Knox 6 hr forecast from the 12Z run on 12/15/14 and International SIGMET "Alfa 2"
Right: GFS 350-400 hPa Ellrod-Knox 6 hr forecast from the 12Z run on 12/15/14 and International SIGMET "Alfa 2"

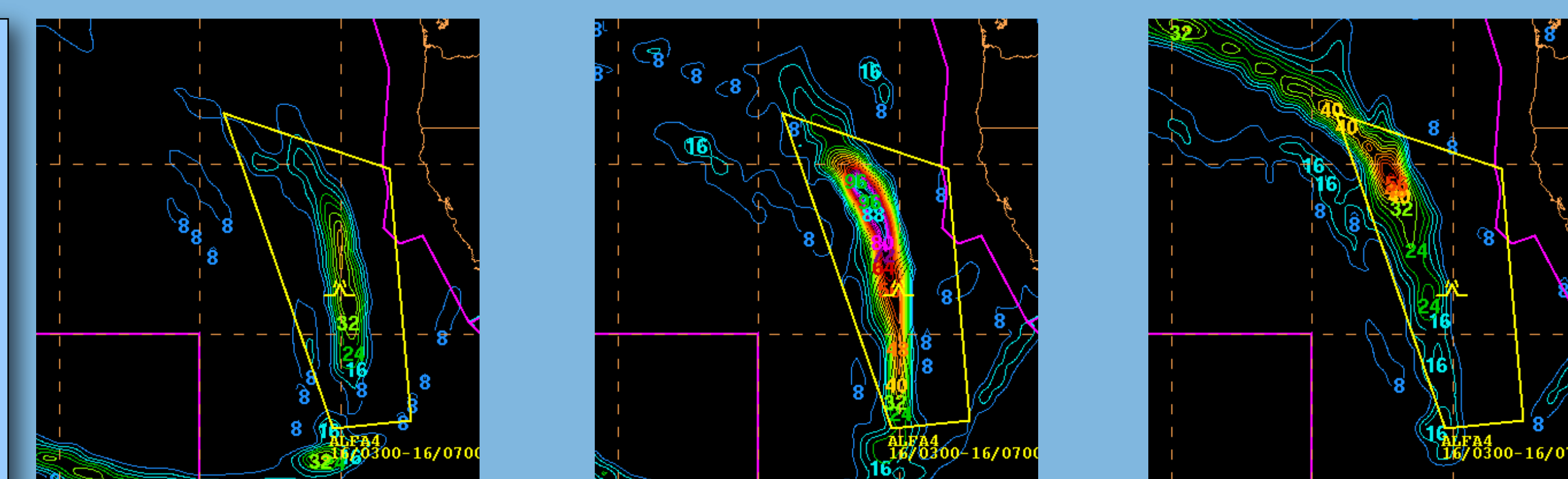


Figure 9. Left: GFS 250-300 hPa Ellrod-Knox 9 hr forecast from the 18Z run on 12/15/14 and International SIGMET "Alfa 4"
Middle: GFS 300-350 hPa Ellrod-Knox 9 hr forecast from the 18Z run on 12/15/14 and International SIGMET "Alfa 4"
Right: GFS 350-400 hPa Ellrod-Knox 9 hr forecast from the 18Z run on 12/15/14 and International SIGMET "Alfa 4"

Conclusions

- Accurate and timely pre-emptive turbulence SIGMETs reduce aircraft encounters with severe CAT over the North Atlantic and Pacific Oceans improving flight safety and increase economic benefits
- The Ellrod-Knox (EK) turbulence diagnostic, in conjunction with other data, improves forecaster confidence to issue pre-emptive CAT SIGMETs up to 3 hours in advance of severe CAT PIREPs, with improved spatial accuracy
- Many forecasters at the AWC have embraced the Ellrod-Knox diagnostic tool to provide better decision support services
- CAT SIGMET Verification: remains difficult because of PIREP paucity and because aircraft avoid SIGMET areas after they are issued
- While Ellrod-Knox is significantly better than previous guidance, additional turbulence guidance improvement is still needed
- Further studies to improve CAT SIGMET lead time, accuracy, and vertical and horizontal extent are in progress